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Mergers in Durable Goods Industries*

Amagoia Sagasta[†] Ana I. Saracho[‡]

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Abstract

This paper is concerned with the study of durability as an aspect of competition and market structure that contributes to determining the incentives for mergers. We find that relative to the incentives in industries that produce non-durable goods the durability of the good produced by an industry enhances the incentive for mergers in the presence of intertemporal consistency problems. Further, the analysis indicates that in durable-good markets a good antitrust policy should combine a restriction to rent solely with a prudent merger policy.

Keywords: Durable Goods, Mergers, Intertemporal Consistency, Strategic Behavior.

JEL Classification: D43, L12, L41.

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1 Introduction

This paper studies the relationship between the durability of the good produced by an oligopolistic industry and the incentives for mergers in the industry. The interactions that may exist between durability and mergers are important for various reasons. Durable goods constitute a very important part of economic production. In 2006, for instance, personal consumption expenditures on durables exceeded 1 trillion dollars in the U.S., and in the manufacturing sector durable goods production constituted roughly 60 percent of aggregate production. Mergers, on the other hand, have also been the subject of keen interest in an important theoretical and empirical literature in industrial organization. Also, as noted in Pesendorfer (2003), mergers and acquisitions have long been a public policy concern. In the United States, Section 7 of the Clayton Act prohibits mergers that “substantially decrease competition or tend to create a monopoly.” In recent years, the volume of mergers and acquisitions in U.S. industries has increased substantially, reaching an unprecedented number of 47,492 premerger notifications received by antitrust regulators during the decade 1997-2006. Given the importance of durable goods in aggregate production, it is no surprise that many of these mergers involved durable goods firms. These reasons provide initial motivation for the analysis in this paper.

The literature on mergers has studied a number of relevant aspects including short run price and output effects, welfare and long-run effects, the impact on research and development and shareholder wealth, investment decisions, and others.¹ From the theoretical perspective, however, it is not clear when mergers are likely to take place. In a non-durable good setting, Kamien and Zang (1990) study the limits of monopolization through acquisition in the absence of any legal barriers but in the presence of firms fully aware of the consequences of acquiring or being acquired by rivals, not susceptible to incredible threats, and behaving strategically with respect to this activity. One of the results they find is that neither complete monopolization nor partial monopolization can be a subgame perfect Nash equilibrium outcome as the number of firms in the industry becomes sufficiently large. Only when the number

¹See, for example, Spector (2003), Pesendorfer (2003), Waldman (2007) and other references therein.

of firms is sufficiently small is complete or partial monopolization possible. To the best of our knowledge, in a durable goods setting no similar analysis exists in the literature.

Besides the fact that durable goods constitute an important part of production and that many durable goods industries are highly concentrated,² an additional motivation to study the feasibility and implications of mergers in durable goods industries is that they have been viewed as *not* posing a threat of significant anti-competitive harm. For instance, the Horizontal Merger Guidelines (section 3.2) of the United States Department of Justice (1997) indicates that “Where the relevant product is a durable good, consumers, in response to a significant commitment to entry, may defer purchases by making additional investments to extend the useful life of previously purchased goods and in this way deter or counteract for a time the competitive effects of concern.”

Also, Carlton and Gertner (1989) note that there are a number of reasons why durable goods industries may be *more* competitive than non-durable goods industries and why it is difficult to create market power through mergers in durable goods industries. One reason is that the stock of durable goods may limit the increase in prices of the new units produced after the merger. Obviously, the effectiveness of this constraint depends on the specific circumstances of the industry. For example, the 1997 case of the Boeing-McDonnell Douglas merger in commercial aircraft may be quite different from mergers among firms that produce agricultural equipment. The reason is that there is much greater scope for more intensive use in agricultural equipment than in the case of aircraft, and hence there is greater potential for the existing stock of used machines to act as a constraint on the behavior of new equipment manufacturers.³ A second reason is the possibility of dynamic strategic interactions among rivals. These interactions may induce an oligopolist to choose to *sell* some of its output rather than rent it. Selling production in turn induces more competitive behavior than renting production. Either of these two effects may alleviate any detrimental effects of mergers.

A number of recent papers have been concerned with the *effects* of mergers in durable-good industries (see for instance Gerstle and Waldman 2004, Waldman 2007,

²As indicated by Driskill (2001) and others, most durable good producers appear to have market power. For example, 90 percent of major household appliances are produced by just five companies.

³For a detailed analysis of the circumstances that may make the stock of durable goods constrain new durable good prices, see Lexecon (2000).

and other references therein). These works study the robustness of the conclusions of the classic paper of Carlton and Gertner. For example, following the analysis of Carlton and Gertner, Gerstle and Waldman analyze the effects of mergers in durable-goods industries, considering an industry that is perfectly competitive prior to the merger, becomes monopolistic after the merger, and again is competitive after the subsequent entry of new firms. The key aspect is that they depart from the Swan-type model of durability used by Carlton and Gertner. Instead, they consider that there is no number of used units that could ever serve as a perfect substitute for a new unit. In their setting the authors find that (i) the welfare loss due to monopoly is larger than that indicated by the previous literature, and that (ii) the reduction in social welfare loss due to durability depends critically on the speed of future entry, and hence this speed should be an important determinant of whether or not durable-goods mergers may be allowed.

In this paper we address a question that is concerned with the endogeneity of mergers in durable good industries but that has not been considered in the literature, namely to what extent the *incentives* for merging are different between durable and non-durable goods industries. We then study the implications of these differences in incentives. In anticipation of the results, we find that both the possibility of strategic interactions among rivals pointed out by Carlton and Gertner and the classic expectations problem associated with durable goods first identified by Coase (1972) *enhance* the incentives to merge.⁴ We argue that this result is relevant in the context of a literature that studies the different aspects of competition and market structure as a determinant of the incentives for mergers.⁵

A standard result in the literature on the durable goods monopoly (e.g., Bulow

⁴Coase conjectured that if consumers have perfect information and are rational, then a monopoly seller of an infinitely durable good without some commitment to limit future production would saturate the market with the competitive output “in the twinkling of an eye” (p. 143).

⁵Salant et al. (1983) consider a model of Cournot competition and show that some exogenous change in market structure (exogenous mergers) may reduce the joint profits of the firms that collude. Considering linear demand and costs they show that in order for a merger to be profitable the number of firms that merge must be at least equal to 80 percent of the industry. Given the empirical evidence on mergers in different industries, this result has motivated the analysis of different aspects of competition that may explain the incentives for merger. In particular, it has been shown that the profitability of a merger is enhanced when, for instance, firms compete in prices (Deneckere and Davidson 1985), the capital stock affects the marginal cost of production (Perry and Porter 1985), or when the principal delegates production decisions to managers (Gonzalez-Maestre and Lopez-Cuñat 2001, Ziss 2001). Fauli-Oller (2001) shows in a Cournot model that profitability of mergers is inversely related to the degree of concavity of demand.

1982, Kahn 1986) shows that when (i) the inverse rental demand for the good is linear and (ii) the firm may only choose the level of production, social welfare is greater if the monopoly sells its output instead of renting it. In practice, firms such as the United Shoe Company, IBM, Xerox and others began by renting their products but were later required also to sell their output. This paper shows that in the absence of mergers, under assumptions (i) and (ii), social welfare is higher and consumer surplus is lower when renting is allowed than when it is forbidden. This result arises because of the strategic interactions among rivals.

The rest of the paper is organized as follows. In Section 2 we describe the framework of analysis. We assume that mergers take place through an acquisition process where the owner of each firm makes bids to buy other firms and sets an asking price for his own firm. In particular, we consider the centralized model of Kamien and Zang, which is extended to allow for durability. Durability is modeled following the classic approach in Bulow (1982). In this framework we then compare the feasibility of endogenous mergers in the following three cases: (i) Renting firms, where firms rent the good in question, (ii) Selling firms, where firms cannot rent but must sell their production, and (iii) Renting-Selling firms where they may both rent and sell their production. In Section 3 we compute and compare the social welfare and consumer surplus in each of these three cases. Section 4 concludes.

2 Theoretical Framework

We consider an oligopolistic industry with $N \geq 2$ identical firms that produce a homogeneous durable good. Entry into the industry is assumed to be unprofitable. In order to analyze the implications that durability of the good produced by the industry and the inability of firms to commit to a future schedule of production may have for mergers, the analysis is implemented in an intertemporal context. There are two discrete periods of time $t = 1, 2$, and the good does not depreciate over time. Thus, every quantity used in the first period can be used in the second period without depreciation. All agents have perfect and complete information and potential buyers of the durable good have perfect foresight. Without loss of generality we assume that the discount factor is 1. The inverse rental demand function for the durable good in each period is $P = a - bQ$, where Q represents the quantity used by consumers in that period. The marginal cost of production of each firm is zero, and there exists a

perfect second hand market for the durable good.

The analysis is modeled as a non-cooperative game that consists of two stages. In the first stage firms engage in a centralized game of acquisition, which means that an owner that acquires several firms behaves as one entity. Given the assumption of zero marginal cost of production, the owner would be indifferent between producing in only one of his firms or distributing production among all of the firms that he owns. For simplicity we will assume that the owner will operate in just one of them. In the second stage, active firms resulting from the merger game engage in quantity competition.

Note that this model can be considered as an extension of the monopolistic case considered by Bulow to the oligopolistic case by simply adding the previous acquisition stage. This model can also be considered as an extension of the model analyzed by Kamien and Zang to the durable goods case by incorporating Coase's time-consistency problem and the strategic interactions among durable good producers.

The solution concept is that of a subgame perfect Nash equilibrium in pure strategies. Therefore, the solution is derived by backward induction from the last stage. As we shall see, given N , multiple structures of the industry may be supported as a subgame perfect equilibrium. In those cases, we will select the one that is efficient from the firms' point of view, that is, the one where there is no other structure that can be supported as subgame perfect equilibrium in which each firm obtains at least as many profits as in the one selected. The following notation will be used:

- q_{1i}^s : quantity sold by firm i in the first period,
- q_{1i}^r : quantity rented by firm i in the first period,
- q_{2i} : quantity sold (or rented) by firm i in the second period,⁶
- q_1^s : quantity sold by the industry in the first period,
- q_1^r : quantity rented by the industry in the first period,
- q_2 : quantity sold by the industry in the second period,
- m : total number of active firms in the industry after the acquisition process.

We now proceed to the resolution of the intertemporal model, first when firms may only rent their output (renting firms); second, when they may only sell their output (selling firms); and lastly when they may both sell and rent their production (renting-selling firms).

⁶Given that the second period is the last one, renting is identical to selling in that period. Hence, no distinction needs to be made.

2.1 Renting Firms

Every initial owner maximizes his payoff, given by his operating profits, less the payments he makes for the firms he purchased, plus the payment he receives for his own firm if it is sold. The problem is solved beginning from the second stage of the game.

SECOND STAGE:

After the acquisition process, each active firm will choose the quantity to be produced in periods 1 and 2 in order to maximize the discounted value of its total profits. Thus, each firm i , $i = 1, \dots, m$, solves

$$\max_{\{q_{1i}^r, q_{2i}\}} (a - bq_1^r)q_{1i}^r + (a - bq_2)q_{2i}.$$

The first order conditions of this problem are

$$a - bq_1^r - bq_{1i}^r = 0,$$

$$a - bq_2 - bq_{2i} = 0.$$

Hence, in equilibrium,

$$q_1^r = q_2 = \frac{am}{b(m+1)}.$$

As a result, the present discounted value of the total profits derived from production for each of the m active firms in the industry, $\pi(m)$, is

$$\pi(m) = \frac{2a^2}{b(m+1)^2}. \quad (1)$$

Clearly, $\pi(m)$ is decreasing in the number of active firms. This is a general property that will hold in each and every situation that will later be analyzed in this paper.

As various authors have noted, the solution of the above maximization problem is dynamically inconsistent unless firms rent their output or, alternatively, if they sell it but can precommit to current buyers that the value of their stock of durable goods will be taken into account in future production.⁷ Precommitment is possible,

⁷Bulow (1982) offers examples of markets in which renting is not feasible. For example, durable intermediate products must be sold and not rented. In our analysis, we will not differentiate between the different possible situations in which the solution given in this subsection is dynamically consistent, for instance between the situation in which the good in question is rented and the situation in which the good is sold but firms precommit by offering best-price provisions. We will just refer to them as the case of renting firms or as the case in which firms coordinate to rent their output.

for example, by offering best-price provisions (Butz 1990), a practice that has been used extensively, for instance, in the electric turbo generating industry and others (see Goering and Boyce 1999).⁸

We analyze next the first stage of the game.

FIRST STAGE:

Kamien and Zang examine the feasibility of mergers in an homogeneous good Cournot oligopoly. Their analysis contains the description of our first stage. More details may be found in their paper.

If an owner has $k \geq 2$ firms in a subgame perfect equilibrium in which there are m active firms, then his payoff must be greater than the payoff he would obtain if he did not buy any other firm, taking into account that he must pay for any acquired firm at least $\pi(m+1)$. Therefore, in equilibrium the following inequality must hold:

$$D(m, k) = \pi(m) - (k-1)\pi(m+1) - \pi(m+k-1) \geq 0. \quad (2)$$

We define a merged subgame perfect equilibrium as a subgame perfect equilibrium in which at least one owner owns more than one firm. In this kind of game, for a given N , there are subgame perfect equilibria in which $m = N$. Following Kamien and Zang, we will call them unmerged subgame perfect equilibria. Note that, given N , every merged subgame perfect equilibrium will dominate the unmerged subgame perfect equilibria since the profits for a firm are decreasing in the number of active firms and in a merged equilibrium $m < N$.

With regard to the structure of the industry resulting from the acquisition game in the case of renting firms, if we take into account (1), condition (2), and the refinement procedure described above, the following proposition can be established:

Proposition 1. *If firms producing a durable good can commit to renting their production, then the structure of the industry resulting from the acquisition game is such that*

- (i). $m = N$ if $N > 2$,
- (ii). if $N = 2$ then $m = 1$.

Proof: Let us now consider the feasibility of merged subgame perfect equilibria. From (1), we have that

⁸For example, General Electric and Westinghouse used best price guarantees during the period 1963-1977.

$$\begin{aligned} D(m, k) &= \frac{2a^2}{b(m+1)^2} - (k-1)\frac{2a^2}{b(m+2)^2} - \frac{2a^2}{b(m+k)^2} = \\ &= \frac{-2a^2(k-1)A(m, k)}{b.(m+1)^2(m+2)^2(m+k)^2}. \end{aligned}$$

Given that $\frac{\partial A(m, k)}{\partial k} > 0$ for all $k > 1$, $A(m, 2) > 0$ for all $m > 1$, $A(1, 3) > 0$, and $A(1, 2) < 0$, we may conclude that $D(m, k) > 0$ if and only if $m = 1$ and $k = 2$. As a result, from (2), the only feasible merged subgame perfect equilibrium is a monopoly if $N = 2$. In addition, there is at least one set of bids and asking prices that supports the monopoly structure as a subgame perfect equilibrium. An example of such set is the following: the asking price set by firm 2, $\pi(2)$, is equal to the bid set by firm 1, the bid set by firm 2 is zero, and the asking price set by firm 1 is $\pi(1)$. The payoffs for owners of firms 1 and 2 will be $\pi(1) - \pi(2)$ and $\pi(2)$ respectively, and obviously no owner has an incentive to change his bid or asking price. ■

The analysis by Kamien and Zang implies that with a linear demand function for a non-durable good and constant returns to scale, there are no mergers in equilibrium with more than two initial firms if they compete à la Cournot. Thus, Proposition 1 implies that when a durable goods industry rents its output, the structure of the industry after the acquisition process is identical to the one corresponding to a non-durable goods industry. The intuition behind this result is that in our context, given the demand function for the services of the durable good, the quantity rented each period by a durable goods industry coincides with the quantity produced by a non-durable good industry with the same number of active firms, m . As a result, $\pi(m)$ is equal to the profits that would be obtained by each of the firms in the repeated Cournot game that arises with non-durable goods. Therefore $D(m, k) > 0$ for the durable goods industry iff $D(m, k) > 0$ for the non-durable goods industry.⁹ Therefore, the comparison of the results concerning the feasibility of merged subgame perfect equilibria in the other two cases to be studied in the paper (selling firms and renting-selling firms) with those corresponding to renting firms is identical to the comparison with the results corresponding to the case of a non-durable good industry.

⁹If firms have constant and positive marginal cost of production, then the quantity rented each period coincides with the quantity produced by a non-durable good industry with identical technology that faces, instead, the inverse demand function $P = \alpha - \beta Q$ with $\alpha = 2a$ and $\beta = 2b$. Hence, as expected, the result in Proposition 1 applies.

Next we study the case of firms that have no commitment ability, that is firms that cannot rent their output.

2.2 Selling Firms

In an oligopoly model in which firms do not have commitment ability, durability introduces the same complexities concerning the interplay between consumer expectations and the time-consistent behavior of the producer that are present in the classic durable-goods monopoly problem. Each period selling firms maximize the present discounted value of profits starting from that period. Thus, in order to calculate the intertemporal consistent schedule of production that maximizes the discounted value of profits for firm i , the maximization problem has to be resolved recursively by backward induction: first we need to determine the optimal production for period $t = 2$, given any production in period $t = 1$, and then calculate the optimal production corresponding to period 1. At $t = 2$, each firm sells the quantity that maximizes its profits corresponding to the second period, given the quantity sold in the first period. Hence, firm i , $i = 1, \dots, m$, will solve the following problem:

$$\max_{q_{2i}} (a - bq_2 - bq_1^s)q_{2i}$$

subject to $q_{2i} \geq 0$. The first order conditions of these $i = 1, \dots, m$ problems imply

$$q_2 = \frac{ma - bq_1^s}{b(m+1)}.$$

Note that the cumulative quantity sold by the industry, $q_2 + q_1^s$, increases with the quantity sold in the first period. Hence, the sale price corresponding to the second period, which coincides with the rental price of that period, decreases with the quantity sold in the first period.

In the first period, each firm sells the quantity that maximizes the present value of its total profits taking into account that the production at $t = 2$ depends on the production at $t = 1$. In equilibrium, since the good is durable and does not depreciate over time, the sale price of the good at $t = 1$ is equal to the sum of the rental prices corresponding to periods 1 and 2. Hence, at $t = 1$ each firm i solves the following problem:

$$\max_{q_{1i}^s} (a - bq_1^s)q_{1i}^s + (a - bq_2 - bq_1^s)(q_{2i} + q_{1i}^s)$$

subject to

$$q_{2i} = \frac{a - bq_1^s}{b(m+1)} \geq 0.$$

Assuming interior solutions, the first order conditions are

$$m(m+3)a - bm(m+3)q_1^s - b(m^2 + 3m + 2)q_{1i}^s = 0, i = 1, \dots, m.$$

Adding up these m conditions we get

$$q_1^s = \frac{m^2(m+3)a}{b(m^3 + 4m^2 + 3m + 2)}; \quad q_2 = \frac{m(m+2)a}{b(m^3 + 4m^2 + 3m + 2)}.$$

Therefore, the present value of the total profits of each firm i is equal to

$$\pi(m) = \frac{(2+m)^2(m^2 + 3m + 1)a^2}{b(m^3 + 4m^2 + 3m + 2)^2}. \quad (3)$$

Let us now consider the first stage of the game. As in the case of renting firms we have that for every N there is an unmerged subgame perfect equilibrium. Thus, we must analyze the feasibility of merged subgame perfect equilibria. With regard to the structure of the industry resulting from the acquisition game when firms do not have any commitment ability, from (3) and condition (2), the following proposition can be established:

Proposition 2. *If firms sell their output and the marginal cost of production is zero, then the structure of the industry resulting from the acquisition game when firms do not have any commitment ability is such that*

- (i). $m = N$ if $N > 3$,
- (ii). $m = 1$ if $N = 2$, or $N = 3$.

Proof: Taking into account (3) we obtain

$$D(m, k) = \frac{(2+m)^2(m^2 + 3m + 1)a^2}{b(m^3 + 4m^2 + 3m + 2)^2} - (k-1) \frac{(3+m)^2(m^2 + 5m + 5)a^2}{b(m^3 + 7m^2 + 14m + 10)^2} - \frac{(1+m+k)^2(m^2 + k^2 + 2mk + m + k - 1)a^2}{b((m+k-1)(m+k)(m+k+2) + 2)^2} = - \frac{a^2 \cdot (k-1) \cdot C(m, k)}{b \cdot F(m, k)},$$

where $F(m, k) > 0$, $\frac{\partial C(m, k)}{\partial k} > 0$ for all $k \geq 3$, $C(m, 3) > 0$ for all $m \geq 2$, $C(m, 2) > 0$ for all $m \geq 2$, and $C(1, 4) > 0$.¹⁰ Thus, it is straightforward to show that $D(m, k) > 0$

¹⁰Proofs are available from the authors upon request.

if and only if $m = 1$ and $2 \leq k \leq 3$. In addition, the following set of bids and asking prices supports those structures of acquisitions as subgame perfect equilibria: the bids (or bid) set for firm 1 coincide(s) with the asking prices (price) set by the rest of the firms, $\pi(2)$. The asking price set by firm 1 is high enough, $\pi(1)$, and the bids set by firms other than firm 1 are low enough, for instance zero. ■

A simple comparison of Propositions 1 and 2 allows us to conclude that mergers are more likely to take place in a selling durable-goods industry than in a renting industry: a monopoly is obtained as a result of the acquisition game for $N \in \{2, 3\}$ rather than for just $N = 2$. The intuitive explanation of this result may be given in terms of the slope of a single firm's reaction curve in period 1 in both contexts.¹¹ A greater slope implies that outsiders will react less aggressively to the merger, and as a result mergers become more profitable. From the first order condition corresponding to the maximization problem solved by firm i in $t = 1$, we obtain that the slope of a single firm's reaction curve is equal to $-\frac{m(3+m)}{2+2m(3+m)}$ for the case of selling firms and $-\frac{1}{2}$ for the case of renting firms. Given that $-\frac{m(3+m)}{2+2m(3+m)} > -\frac{1}{2}$, it is immediate to conclude that outsiders will react less aggressively to the merger in the case of selling firms than in the case of renting firms. The reason is that in the first case an increase in the production in period 1 induces a reduction in the residual demand corresponding to the second period.

In the analysis we have assumed that the marginal cost of production is zero and that the discount factor is equal to one. It is important to discuss the role that these two simplifying assumptions play. On one hand, it is not difficult to show that if the marginal cost of production is independent of the level of production and sufficiently high relative to a (in particular, greater than $\frac{a}{2}$) then, given m , the level of production and the profits of each firm would be identical to the ones corresponding to the rental case. As shown earlier, in this case the only merged subgame perfect equilibrium is a monopoly if $N = 2$. On the other hand, we have that it is precisely when the future is important enough, that is, when the discount factor is high enough, that the intertemporal consistency problem is more relevant. Obviously, in the extreme case in which the discount factor is zero there is no such a problem and the analysis is identical to the one corresponding to the non-durable goods case: the only one merged subgame perfect equilibrium is a monopoly if $N = 2$. In fact, it is not difficult to

¹¹We are indebted to an anonymous referee for this observation.

show that with selling firms and zero marginal cost of production a monopoly is a subgame perfect equilibrium when $N = 3$ if and only if the discount factor v is high enough (more precisely, iff $v > 0.65$).

Lastly, we consider the case in which firms may both rent and sell their outputs but they do not coordinate to rent them.

2.3 Renting-Selling Firms

If firms can rent and sell their outputs, then in equilibrium each firm will sell part of its production even though its profits would be greater if all of them coordinated to rent their production (Carlton and Gertner) since a firm selling a durable good today is stealing sales from its rivals both today and tomorrow. Therefore, given that consumers have perfect foresight, the problem involves both the dynamic reactions among oligopolists and the time-consistency problem identified by Coase. The set up of the model in this section corresponds to the analysis of Carlton and Gertner assuming that there is no depreciation. Following their analysis, the industry production levels are

$$q_1^s = \frac{am(m-1)}{b(m^2+1)}; \quad q_1^r = \frac{2am}{b(m+1)(m^2+1)} \text{ and } q_2 = \frac{am}{b(m^2+1)}.$$

Details of the resolution may be found in their paper. Taking into account the industry production levels and that firms are identical, it is straightforward to conclude that the present value of total profits for firm i , $i = 1, \dots, m$, is

$$\pi(m) = \frac{a^2(m^4 + m^3 + 4m^2 + m + 1)}{b(m+1)^2(m^2+1)^2}. \quad (4)$$

With regard to the merged subgame perfect equilibria for renting-selling firms, using this expression and condition (2) the following proposition can be established:

Proposition 3a. *If in equilibrium firms rent and sell output then the merged subgame perfect equilibria are*

- (i). *a monopoly if $N \in \{2, 3\}$,*
- (ii). *a duopoly if $N \in \{3, 4\}$.*

Proof: Taking into account (4), we get that

$$D(m, k) = \frac{a^2(m^4 + m^3 + 4m^2 + m + 1)}{b(m+1)^2(m^2+1)^2} - (k-1) \frac{a^2(m^4 + 5m^3 + 13m^2 + 16m + 8)}{b(m+2)^2(m^2+2m+2)^2} -$$

$$\frac{a^2((m+k-1)^4 + (m+k-1)^3 + 4(m+k-1)^2 + m+k)}{b(m+k)^2(m^2 + k^2 + 2mk - 2m - 2k + 2)^2} = -\frac{a^2(k-1)G(m,k)}{bH(m,k)},$$

where $H(m,k) > 0$, $\frac{\partial G(m,k)}{\partial k} > 0$ for all m, k such that $m \geq 2$ and $k \geq 2$, $G(2,3) > 0$, $G(m,2) > 0$ for all $m \geq 3$ and $G(1,4) > 0$.

Thus, it is straightforward to show that $D(m,k) > 0$ if and only if either $m = 1$ and $k \in \{2,3\}$, or $m = 2$ and $k = 2$. Notice that $D(2,2) > 0$ implies that if either $N = 3$ or $N = 4$, then a duopoly is a feasible merged subgame perfect equilibrium. The set of bids and asking prices given in the proof of Proposition 2 support the structure of acquisitions necessary to have a monopoly for $N = \{2,3\}$ as subgame perfect equilibrium.

Lastly, for $N = 3$ or $N = 4$ the following set of bids and asking prices supports the structures of acquisitions that induce the industry to become a duopoly as a subgame perfect equilibrium: the bid set by every firm that acquires another firm coincides with the asking price set by the acquired firm and it is equal to $\pi(3)$; the rest of the bids are sufficiently low, say zero, and the rest of asking prices are sufficiently high, say $\pi(1)$. ■

It is not difficult to show that the results in Proposition 3a are maintained for constant marginal costs of production that are low relative to a and for discount factors that are sufficiently high (in particular, for $v > 0.69$).

From Proposition 3a we may establish the following result with regard to the final structure of the industry after the acquisition process.

Proposition 3b. *The structure resulting from the acquisition game with renting-selling firms is such that*

- (i). $m = N$ if $N > 4$,
- (ii). $m = 2$ if $N = 4$,
- (iii). $m = 1$ if $N = 2$, or $N = 3$.

Proof: From Proposition 3a it is straightforward to show that parts (i), (ii) and (iv) hold true. Thus, we only need to show that if $N = 3$, then the structure $m = 2$ is dominated by the structure $m = 1$. Let us denote by π_i the profits of the owner of firm i . Given that for $m = 2$, π_3 is at most equal to $\pi(2) - \pi(3)$, whereas for $m = 1$, π_3 is at least as high as $\pi(2)$, it is clear that the structure $m = 1$ cannot be dominated by the structure $m = 2$.

We analyze now whether the structure $m = 2$ can be dominated by the structure $m = 1$. Consider those equilibria in which an owner who acquires a firm pays for it a quantity equal to $\pi(m + 1)$. From (5) we get that if $m = 1$, then $\pi_1 = \pi(1) - 2\pi(2) = \frac{53a^2}{450b}$ and $\pi_i = \pi(2) = \frac{43a^2}{225b}$ with $i = 2, 3$, whereas if $m = 2$, then $\pi_1 = \pi(2) - \pi(3) = \frac{71a^2}{720b}$, $\pi_2 = \pi(2) = \frac{43a^2}{225b}$ and $\pi_3 = \pi(3) = \frac{37a^2}{400b}$. Just comparing the profits of each firm in these cases, we obtain that the structure $m = 1$ dominates the structure $m = 2$. Therefore, (iii) also holds true. ■

Comparing Propositions 1, 2 and 3b we may conclude that the incentives for mergers are highest in the presence of renting-selling firms. In order to understand why this is the case, it is important to note that in the absence of marginal production costs, rental production has no effect on future competition. In fact, the restriction given by the behavior of firms in $t = 2$ implies, as in the case of selling firms, that $q_{2i} = \frac{a - bq_1^s}{b(m+1)}$. That is, the quantity sold by the industry in the second period depends only on the quantity sold in period 1. The first order conditions corresponding to the maximization problem solved by firm i , $i = 1, \dots, m$, in $t = 1$ are

$$a - bq_1^s - bq_1^r - bq_{1i}^s - bq_{1i}^r = 0 \text{ and } \frac{m(m+3)}{(m+1)^2}(a - bq_1^s) - b(q_1^r + q_{1i}^r) - \frac{(m+2)}{(m+1)^2}bq_{1i}^s = 0.$$

From the first condition we know that $b(q_1^r + q_{1i}^r) = a - bq_1^s - bq_{1i}^s$. By replacing it in the second equation, we may express the conditions as follows:

$$a - b(q_1^s + q_{1i}^r) - b(q_{1i}^s + q_{1i}^r) = 0 \text{ and } (m-1)a - (m-1)bq_1^s - (m+1)bq_{1i}^s = 0, \quad i = 1, \dots, m.$$

Hence, the slope of a single firm's reaction curve in period 1 is equal to $-\frac{1}{2}$, as in the case of renting firms. Note, however, that the level of sales for firm i in period 1 depends only on the level of sales of the rest of firms in that period. Moreover, the slope of the function that captures this dependence is equal to $-\frac{m-1}{2m}$, which is greater than the slope in the case of selling firms, $-\frac{m(3+m)}{2+2m(3+m)}$. Hence, when the sales of the other firms in period 1 decrease, firm i reacts by increasing in that period both the quantities rented and sold. As a result the increase of the quantity sold in period 1 is lower than the corresponding to the case of selling firms. Therefore, firms behave less aggressively than in the case of selling firms since it is only the level of sales in period 1 that has an effect on future competition.

Lastly, a simple comparison of Propositions 1, 2 and 3b allows us to establish the main result of the paper.

Proposition 4. *If the good produced by the industry is durable, then complete monopolization and partial monopolization are more likely to take place in the presence of the time-consistency problems induced by durability.*

As discussed throughout the paper, the presence of time-consistency problems implies that mergers are more likely to take place in durable goods industries than in non-durable goods industries.¹² Given these differences, in order to analyze the effects of the different practices (renting or selling) on social welfare and consumer surplus, it is important to take into account the incentives to merge. We study this aspect next.

3 Consumer Surplus and Social Welfare

The literature on durable goods industries has studied a number of different issues (e.g., the determinants of planned obsolescence, social welfare, etc.) assuming that firms can either rent or sell their production but not both (see, for example, Bulow 1986, Kahn 1986, Goering 1992, Driskill 2001, and other references therein). As indicated by Bulow (1982), renting may often be ruled out for legal reasons. For example, United Shoe Company, IBM, and Xerox began by only renting their products but were later required at some point to also sell them. The results in the previous section indicate that it is precisely in this situation when mergers in durable goods industries are more likely to take place. Given that in the context considered in this paper firms are symmetric and there are no economies of scale or fixed costs, a merger will induce a welfare loss. Also, from the analysis above it may be concluded that a regulatory constraint that establishes that the share of the firms that participate in the merger must be lower than 50% will imply that the game does not have a merged subgame perfect Nash equilibrium. These aspects raise the question of what the net effects are on social welfare of the different practices (renting or selling) both when we take and when we do not take into account the incentives to merge.

In what follows social welfare will be measured as the sum in present value of firms' profits and consumer surplus. From Section 2, we know that a necessary condition for a merged subgame perfect equilibrium to exist in at least one of the three possible situations considered (renting, selling, renting-selling firms) is that the

¹²It is not difficult to show that the result in Proposition 4 also applies to the case of exogenous mergers.

number of firms in the industry is at most four (i.e., $N \leq 4$). In this section we will first compare consumer surplus and social welfare in each of these situations in the cases where there is no merged subgame perfect equilibrium and as a result $m = N$. Then, for $N \leq 4$ we will analyze the effects on consumer surplus and social welfare that arise from the interplay between the different practices (renting or selling) and the incentives to merge.

3.1 Social Welfare When There Are No Merged Subgame Perfect Equilibria

Given that the cost of production is zero, it follows that both social welfare and consumer surplus increase with the quantity of goods used by consumers each period.¹³ The quantity used in the market each period t , Q_t^j , where $j = r, s, r - s$ denotes the cases of renting firms, selling firms, and renting-selling firms respectively, is such that

a. On one hand, we have $Q_1^{r-s}(m) = Q_1^r(m)$ and $Q_2^r(m) < Q_2^{r-s}(m)$. As result of the strategic effects that exist in the renting-selling oligopoly industry, we have behavior being more competitive than in the renting firms oligopoly industry or, equivalently, than in the repeated Cournot game that arises with non-durable goods. Thus, given m , social welfare and consumer surplus are greater in the case of renting-selling firms than in the renting case. The incentive to sell arises solely for strategic reasons and tends to cause both the price and the deadweight loss to be lower than what they would be in the case of renting firms.

b. On the other hand, we have that $Q_1^{r-s}(m) > Q_1^s(m)$ and $Q_2^{r-s}(m) < Q_2^s(m)$. Due to the time-consistency problem, selling firms produce in the first period a quantity that is lower than that produced by renting or renting-selling firms. The reason is that this is the only commitment mechanism that firms have for not flooding the market in the second period. Otherwise, since consumers are rational, flooding the market would imply a decrease in the prices at which the good is sold in each of the periods.

In general, given a number of active firms m , social welfare $W(m)$ and consumer surplus $CS(m)$ may be written as

¹³The quantity used in the second period will be equal to the sum of the quantities sold each period. The quantity used in the first period will be equal to the sum of the quantity sold and the quantity rented in that period.

$$\begin{aligned} W(m) &= \int_0^{q_1^s(m)+q_1^r(m)} (a - bQ)dQ + \int_0^{q_1^s(m)+q_2(m)} (a - bQ)dQ, \\ CS(m) &= \frac{b}{2}[(q_1^s(m) + q_1^r(m))^2 + (q_1^s(m) + q_2(m))^2]. \end{aligned}$$

Hence, from the analysis in Section 2 it is straightforward to conclude that social welfare $W^j(m)$ and consumer surplus $CS^j(m)$ in each of the three cases considered, $j = r, s, r - s$, are

$$\begin{aligned} W^r(m) &= \frac{a^2 m(2 + m)}{b(m + 1)^2}, \\ CS^r(m) &= \frac{m^2 a^2}{b(m + 1)^2}; \\ W^s(m) &= \frac{a^2 m(2m^5 + 16m^4 + 43m^3 + 50m^2 + 36m + 8)}{2b(m^3 + 4m^2 + 3m + 2)^2}; \\ CS^s(m) &= \frac{a^2 m^2(2m^4 + 14m^3 + 29m^2 + 16m + 4)}{2b(m^3 + 4m^2 + 3m + 2)^2}; \\ W^{r-s}(m) &= \frac{a^2 m(2m^5 + 4m^4 + 5m^3 + 8m^2 + 3m + 2)}{2b(m^2 + 1)^2(m + 1)^2}; \\ CS^{r-s}(m) &= \frac{m^2 a^2(2m^4 + 2m^3 + 3m^2 + 1)}{2b(m^2 + 1)^2(m + 1)^2}. \end{aligned}$$

As a result,

$$W^{r-s}(m) > W^s(m) > W^r(m) \text{ and } CS^s(m) > CS^{r-s}(m) > CS^r(m) \text{ for all } m > 1,$$

whereas

$$W^s(1) > W^{r-s}(1) = W^r(1) \text{ and } CS^s(1) > CS^{r-s}(1) = CS^r(1).$$

Hence, if there is no merged subgame perfect equilibria and firms cannot coordinate to rent all of their production, then it is optimal, from the social point of view, that renting output is allowed. However, this is not optimal from the consumers' point of view. Note that only for the case of monopoly do we obtain that social welfare maximization implies that renting should be forbidden.

As shown earlier, in the absence of prohibitions imposed by the antitrust authorities the incentives to merge are different depending on whether we have renting, selling, or renting-selling firms. We next compare social welfare, consumer surplus, and the welfare loss due to mergers for these three cases when there are merged subgame perfect equilibria.

3.2 Incentives to Merge and Social Welfare

Merged subgame perfect equilibria are feasible only if $N \leq 4$. We next analyze and compare social welfare and consumer surplus under the different practices of the firms in each of the three initial structures of the industry in which there is some merged subgame perfect equilibrium.

(i) If $N = 2$, we know that in every situation there is one merged subgame perfect equilibrium that is a monopoly. From the analysis above, we know that

$$W^s(1) > W^{r-s}(1) = W^r(1) \text{ and } CS^s(1) > CS^{r-s}(1) = CS^r(1).$$

Hence, in this situation it would be optimal from both the social welfare and the consumer surplus points of view not to allow firms to rent.

(ii) If $N = 3$, there are merged subgame perfect equilibria only when firms sell their production either totally or partially (see Propositions 1, 2 and 3b). In both of these cases the result of the acquisition problem would be complete monopolization: $m = 1$. As a result, on one hand social welfare and consumer surplus are greater in the case of selling firms; on the other hand, with renting firms we have $m = 3$, and therefore by comparing social welfare and consumer surplus for renting firms and selling firms, we may conclude that

$$W^r(m = 3) - W^s(m = 1) = \frac{15a^2}{16b} - \frac{155a^2}{200b} > 0,$$

and

$$CS^r(3) - CS^s(1) = \frac{9a^2}{16b} - \frac{13a^2}{40b} > 0.$$

Hence, it would be optimal from the viewpoints of social welfare and consumer surplus not to allow firms to sell their output because of the incentives they have to merge.

(iii) If $N = 4$, then the only merged subgame perfect equilibrium corresponds to the case of renting-selling firms. Such equilibrium is a duopoly. If firms are either

renting or selling, then there would be 4 active firms in the industry. As a result we have that

$$W^r(4) - W^{r-s}(2) = \frac{24a^2}{25b} - \frac{208a^2}{225b} > 0,$$

and

$$CS^r(4) - CS^{r-s}(2) = \frac{16a^2}{25b} - \frac{122a^2}{225b} > 0.$$

Therefore, if firms are allowed to rent their production because of the incentives to merge, it would be then desirable from the viewpoint of social welfare, and even from the consumers' viewpoint, that they coordinate to rent it. However, since $W^s(m) > W^r(m) \forall m$, the appropriate prescription would be to forbid renting the good.

The results obtained thus far suggest that it is important to analyze whether mergers in durable-goods industries potentially pose as many problems as in non-durable good markets. Put differently, a relevant question is whether mergers in durable-goods industries may be posing a threat of significant anticompetitive harm.

In a context with two periods of time and where the demand for the services of the good does not change over time, the comparison of the welfare loss due to merging in the cases of selling and renting-selling firms with the welfare loss corresponding to the case of renting firms is identical to the comparison with respect to the case of a non-durable good industry. The reasons are that there are no costs of production and that, as shown earlier, the quantity rented each period by a durable goods industry coincides with the quantity produced each period by a non-durable good industry with the same number of active firms. Taking into account the expressions corresponding to social welfare $W^j(m)$ obtained in section 3.1, it is straightforward to conclude that the welfare loss, in percentage terms, due to mergers is not lower in the case of durable goods than in the case of non-durable goods. More precisely, we have that for $N = 2$ the welfare loss of merging, WL^j , is $WL^r = 15.62\%$, $WL^s = 15.93\%$ and $WL^{r-s} = 18.87\%$; for $N = 3$ we have $WL^r = 0$ since in this case (renting firms) there are no mergers, $WL^s = 19.37\%$ and $WL^{r-s} = 22.17\%$, and for $N = 4$ we have $WL^r = WL^s = 0$ since there are no mergers in these cases, and $WL^{r-s} = 5.5\%$.

In conclusion, the analysis in this section suggests that in durable-good markets a good antitrust policy should combine a restriction to rent solely with a prudent merger policy.

4 Conclusions

We have analyzed the effects of durability on the incentives to merge. These effects have relevant implications for the literature on mergers and for the analysis of the effects on social welfare and consumer surplus of the different practices used in the commercialization of durable goods. Our main conclusion is that, relative to the case of non-durable goods, Coase's intertemporal consistency problem and the strategic interactions among firms in a durable good industry enhance the incentives for mergers.

Durable goods occupy a prominent role in aggregate economic production in the US and other developed countries, and mergers and acquisitions have experienced a substantial increase in recent years. Despite an important body of theoretical and empirical work in the literature on mergers and acquisitions, the relationship between the intertemporal consistency problem present in durable goods and the incentives for mergers have not been studied in the literature. The implications of the analysis are not trivial and seem relevant for public policy issues regarding antitrust policies, for the analysis of the effects of different commercialization practices concerning durable goods, and may also represent a valuable source for empirical work in future research.

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